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Finally, the liberality of Professor Pierce, the Superintendent of the Coast Survey, in placing at the service of the Fish Commissioner a fine steamer and every convenience for dredging during an entire month, leads us to indulge the hope that it may in the future seem necessary to the work of the Coast Survey, to make a map of the sea bottom within soundings. The soundings in such case would be better done by the dredge than the lead, as a far better idea of the sea bottom could thus be obtained, than by the slight amount of material usually brought up by the lead, and which is sometimes misleading. A naturalist aboard could sort out the animals and send them to experts for identification. Thus, with slight extra expense, the work already begun by M. Pourtales in mapping out the bottom of the Straits of Florida, could be extended, and our north Atlantic sea bottom would be studied and mapped out, and the results, while advancing science, be of great practical value in navigation and the fisheries.

THE YELLOWSTONE NATIONAL PARK.

BY THEO. B. COMSTOCK, B.S.

II. ITS IMPROVEMENT.

HAVING shown, I trust conclusively, the value of the park from a scientific standpoint, we may now consider in a general manner the best and most advantageous methods of maintaining and utilizing its peculiarities. Before proceeding to the discussion of this subject, it will be well to state the provisions of the act of March, 1872, which relate specially to the control and improvement of the dedicated tract of land. I quote the following passages:

“All persons who shall locate or settle upon, or occupy the same, or any part thereof, *except as hereinafter provided*, shall be considered trespassers and removed therefrom.”

“Said public park shall be under the exclusive control of the Secretary of the Interior, whose duty it shall be, as soon as practicable, to make and publish such rules and regulations as he may deem necessary or proper, for the care and management of the

same. Such regulations shall provide for the preservation from injury or spoliation, of all timber; mineral deposits, natural curiosities, or wonders within said park, and their retention in their natural condition. The secretary may, in his discretion, grant leases for building purposes for terms not exceeding ten years, of small parcels of ground, at such places in said park as shall require the erection of buildings for the accommodation of visitors; *all of the proceeds of said leases, and all other revenues to be expended under his direction in the management of the same,* and the construction of roads and bridle paths therein. *He shall provide against the wanton destruction of the fish and game . . . and against their capture or destruction for the purposes of merchandise or profit, ... and generally shall be authorized to take all such measures as shall be necessary or proper to carry out fully the objects and purposes of this act."**

It is impossible to find fault with this bill, so far as it goes, for it is a model of concise expression, while it is certainly explicit enough to show clearly its objects and intentions; nevertheless it is marked by one of those strange inconsistencies which seem inseparable from our present system of *unadvised* legislation upon matters connected with public improvements.† I refer to the authority given to the Secretary of the Interior and the duties thereby imposed upon him, without the power of exercising the one or of fulfilling the other. Ample provision has been made for the protection and preservation of the park and its denizens, *provided that no one attempts to injure or destroy within its borders.* But in this, as in other cases, the necessity which has produced

* So far as I am aware no further legislation has been made since the passage of this bill. I have omitted only those portions which refer to the boundaries of the park, with certain passages not essential to completeness of expression.

† I feel it to be due to myself, in consideration of a certain air of novelty or incompleteness which may attach to this article, to state more definitely my position with respect to the question of the relations of science to the General Government. I take this opportunity of recording my views upon this subject not only that I may be more fully understood in the plans here proposed, but also because I believe that the time has come for combined action on the part of scientists. In brief, then, it is my firm conviction that the present system (if such it can be termed) of *unorganized and indiscriminate* appropriation of the public funds for scientific purposes is, to say the least unprofitable and detrimental to the best interests of science. This conclusion, based as it is upon a careful study of the facts in the case, naturally leads to the question whether any method possessing equal or greater advantages could be adopted which would have fewer objections. After mature deliberation, I am confident that this is quite possible, as I shall hope to demonstrate hereafter. I cannot now enter into details, nor is it necessary for my present purpose, but these remarks may serve to explain in a measure what might otherwise appear paradoxical or impracticable.

the law demands its execution.* Thus far I am not aware that much has been lost by delay in this respect, for the simple reason that the mere fact that a law exists is sufficient for a short time to deter many from transgressing it. It has now become apparent, however, that there is no "power behind the throne," and so long as this state of affairs continues the danger of spoliation is liable to increase.

Again, the bill does not provide for the improvement of the reservation in any way except that "all of the proceeds of leases, and all other revenues which may be derived from any source connected with said park," are to be expended in its management and the construction of roads. To say nothing of the fact that the first proceeds of such a fund, which is never likely to assume gigantic proportions, must be devoted to the payment of a superintendent's salary, it is evident that "the construction of roads and bridle paths therein" must precede "the erection of buildings for the accommodation of visitors." These roads must, therefore, be constructed in the early future, if the park is to become in any degree the place of resort for which it is intended.

As I have remarked, the whole of this district is now in a state of nature, and while this is by no means unfavorable to investigation, but, in many respects, quite the reverse, it is not conducive to a high state of physical vigor upon the part of the investigator. Until access to the Yellowstone Park from without and movement from place to place within its borders is rendered comparatively easy by the opening of suitable roads, food and other supplies must be transported by pack-trains a distance of more than one hundred miles. This method is not only tedious and expensive, but it is also attended with considerable risk, and the more delicate instruments which are indispensable for accurate work in some departments cannot be transported in this manner at all.† The first requirement for scientific work is, therefore, a

* President Grant, in his late message, recommends legislation to this end, and it is not improbable that it will receive the attention of Congress during this session. The Secretary of the Interior has done all in his power by the appointment, in 1872, of Hon. N. P. Langford, as superintendent. This gentleman has done far more than could be expected of him, and has regularly presented his reports, notwithstanding the fact that his services have been rendered with great sacrifice of comfort, and, so far as I can learn, wholly without compensation.

† Barometers and thermometers can only be carried with safety, by being packed with the greatest care, and strapped to the back of a rider who will rarely allow his animal to move out of a walk. The instances are rare indeed in which chronometers in

system of roads which will afford communication between the principal points of interest. This accomplished, there can be no doubt of the speedy introduction of better methods of transport from without. The enterprising citizens of Montana and Wyoming, encouraged by General Ord, have already agitated the subject of an extended system of national highways through the Territories, and vigorous measures have been adopted to secure their object. This would add greatly to the facilities in this direction, for as I have shown, any direct route between the Montana settlements and the south or east must pass through this reservation or very near to it. But the project of a railroad through that section is not in its infancy, nor can it long be delayed. It is unnecessary to dwell upon these points, for it is obvious, from what has been said, that the attention of capitalists must soon be turned toward this field. I will therefore proceed to show in what ways I consider that the interests of science can be best furthered.

Too much stress cannot be laid upon the great importance of *prompt, constant, extended and connected observation* of the rare and rapidly waning phenomena, which form the most striking and characteristic features of the district under consideration. Taking these points in the order named, it ought to be understood that in order to obtain thoroughly satisfactory results

Action must be prompt.—The evidence thus far obtained, though meagre and fragmentary, points directly to the conclusion that constant changes are taking place in the movements of the geysers and boiling springs, resulting occasionally in the apparent extinction of an active crater, the sudden eruption of one long dormant, or a radical change in the manner of action of another.

The whole region abounds with traces of geysers, solfataras, and other minor evidences of the persistency of heat after the dying out of the volcanic furnaces, proving that the active vents are representatives of the last stage of such action. Several interesting geysers, to which I shall presently refer, have changed in character more or less since first observed.

The Giant Geyser was observed in action in 1870 by Lieut. G. C. Doane, who reports that the eruption continued during three and a half hours. At the time of Dr. Hayden's visit in the following year, the only eruption recorded, though quite as vigorous

use have been successfully transported upon horseback, even with the utmost care and precaution under very favorable circumstances.

as that mentioned by Doane, lasted only one hour and twenty minutes. This geyser was not observed in action by any of Dr. Hayden's party of 1872, nor by the members of the northwestern Wyoming expedition in 1873.*

If we are to reap the greatest benefit from the study of these phenomena, it cannot be denied that "delay is dangerous."

Observation must be constant.—The closest attention to details will avail little, however early, unless ample provision be made for its continuance without interruption. Temporary exploring parties have done their work so far as these are concerned, in the discovery and mapping of their positions, and in gleaning sufficient evidence to show their importance. Every scrap of this evidence is valuable, to be sure, but the main questions at issue can be decided only by the steady and laborious process of accumulating related and coincident facts. This necessity will be more apparent when we consider our ignorance of the phenomena. I can best illustrate this by a brief reference to the known history of several of the most prominent of the craters of the Upper Geyser Basin of Fire Hole River.

The eruption of the "Giantess" so graphically described by Mr. Langford,† who witnessed two violent eruptions within twenty-two hours in 1870, has since been observed only once, on the evening of August 18, 1872, by a portion of Dr. Hayden's party.‡

Another geyser a few rods distant from the "Giantess," but across the river, on account of the approximate regularity of its action, has received the appropriate name of "Old Faithful." I give on the following page a table of twenty-seven eruptions with particulars.§

*Dr. A. C. Peale, Hayden's "Report" 1872, p. 153, says:—"The water in the Giant Geyser seemed to be considerably agitated, but never reached a greater height than about three feet above the top." This was also its condition at the time of my visit last August. This is but one of many similar instances which might be given in illustration of my remarks.

†"Scribner's Monthly," June, 1871.

‡Mr. Langford reports the maximum height of the column of *water* projected from this geyser to have been 250 ft. Dr. Peale (*loc. cit.*, p. 149) places the height, in 1872, at less than 40 ft.

§The seventeen eruptions observed in 1872 are taken from the Report of Dr. Peale, (*loc. cit.*, p. 148). The remainder are from my own notes. Lieut. S. E. Blunt rendered material assistance in this instance.

TABLE.

No. of eruption.	Date.	Eruption began.	Eruption ceased.	Duration.	Intervals of quiet.
	1872,	<i>h. m. s.</i>	<i>h. m. s.</i>	<i>m. s.</i>	<i>h. m. s.</i>
1.	Aug. 17.	3 22 00 P. M.	3 27 00 P. M.	5 00	.....
2.	Aug. 18.	7 27 30 A. M.	7 32 30 A. M.	5 00	.....
3.	Aug. 18.	8 35 30 A. M.	8 40 30 A. M.	5 00	1 03 00
4.	Aug. 18.	9 40 30 A. M.	9 46 30 A. M.	6 00	1 00 00
5.	Aug. 18.	10 46 26 A. M.	10 51 13 A. M.	4 47	0 59 56
6.	Aug. 18.	11 54 31 A. M.	11 59 10 A. M.	4 39	1 03 18
7.	Aug. 18.	1 05 05 P. M.	1 09 46 A. M.	4 41	1 05 55
8.	Aug. 18.	2 15 25 P. M.	2 20 15 P. M.	4 50	1 05 39
9.	Aug. 18.	3 23 51 P. M.	3 28 22 P. M.	4 31	1 03 36
10.	Aug. 18.	4 33 22 P. M.	4 38 22 P. M.	5 00	1 05 00
11.	Aug. 18.	5 41 00 P. M.	5 46 00 P. M.	5 00	1 02 38
12.	Aug. 18.	6 42 30 P. M.	6 47 15 P. M.*	4 45	0 56 30*
13.	Aug. 18.	7 44 30 P. M.	7 49 20 P. M.*	4 50	0 57 15*
14.	Aug. 18.	8 51 00 P. M.	8 55 20 P. M.*	4 20	1 01 40*
15.	Aug. 19.	10 07 00 A. M.	10 11 45 A. M.	4 45*	.....
16.	Aug. 19.	11 12 30 A. M.	11 17 20 A. M.	4 50*	1 00 45
17.	Aug. 20.	11 54 00 A. M.	11 58 20 A. M.	4 20*	.....
	1873.				
1.	Aug. 25.	11 36 00 A. M.	11 41 30 A. M.	5 30	.....
2.	Aug. 25.	12 39 00 P. M.	12 44 00 P. M.	5 00	0 57 30
3.	Aug. 25.	1 41 15 P. M.	1 45 45 P. M.	4 30	0 57 15
4.	Aug. 25.	2 45 20 P. M.	2 50 00 P. M.	4 40	0 59 35
5.	Aug. 25.	3 53 35 P. M.	3 58 00 P. M.	4 25	1 03 35
6.	Aug. 25.	5 11 10 P. M.	5 15 40 P. M.	4 30	1 13 10
7.	Aug. 25.	6 03 15 P. M.	6 07 45 P. M.	4 30	0 47 25
8.	Aug. 25.	7 12 00 P. M.	.....	.....	1 01 15
9.	Aug. 25.	8 14 00 P. M.	.....	.....	.....
10.	Aug. 25.	9 17 00 P. M.	.....	.....	.....

The following tabular list gives the number of recorded eruptions of ten of the best known geysers of the Upper Basin of Fire

*These data, for some unexplained reason, are omitted from Dr. Peale's table, and I have supplied them by simple calculation from the other figures which he gives.

Hole River. If there be any errors, it will be found that the total number is larger than the truth.*

NAME OF GEYSER.	No. of recorded eruptions.	Maximum height of column of water projected according to different observations.		Character of Geyser.†
		Feet.	Feet.	
Old Faithful.....	30	100 to 150		Regular.
Giantess	3	39 to 250		Irregular?
Beehive	7	100 to 219		Irregular?
Castle	7	25 to 93		Ftful.
Grand	8	173 to 225		Regular?
Turban.....	3	25 to 30		Regular?
Giant.....	3	140 to 200		Constant.
Grotto	4	41 to 45		Irregular?
Saw-mill		15 to 25		Constant.
Riverside	3	40		Regular?
Total of recorded eruptions of nine of the best known geysers.....	68			

These facts not only tend to show plainly the paucity of our knowledge, but they furnish in themselves sufficient evidence of the amount which we may hope to gain by a closer study, based upon a wider knowledge resulting from constant observation.

Extended observation is required.—All of the expeditions which have heretofore visited this section have done so during the summer months; hence we have no records of any phenomena within

* This table is intended to include all known observations of eruptions made between 1869 and the present time. As a number of small parties of tourists, miners and others have from time to time visited this locality, it is probable that other eruptions have been witnessed, of which no records have been made in an accessible form. Several of the geysers in this list have also been seen in action by exploring parties without accurate observation. For obvious reasons, I have taken no account of such cases in my list.

† It is impossible from such a small number of ascertained facts, to classify these geysers *correctly*. In the case of "Old Faithful" enough is known to entitle it to be considered regular (approximately) in its action. The terms employed here to denote the character of the "Castle," "Giant" and "Saw-mill" geysers also express clearly enough their respective conditions, *at present*. As for the others, their status is very doubtful.

these limits for a greater period than three consecutive months. The most interesting localities, consequently, have been in all cases very hastily examined. Dr. Hayden has published topographical maps showing the distribution of the principal geysers and hot springs of the upper and lower Fire Hole Basins, and of Shoshone Lake, to most of which he has given more or less appropriate names, but upon neither of his trips did he remain long enough in any one locality for extended observations. The expedition of last summer* was able to devote but a portion of the time to the area included in the park, and the remaining parties have been not only quite small, but they have been much more restricted for want of time.† All of the facts have been collected during the warmest and driest season of the year when the atmospheric precipitation is least abundant and permanent. We know absolutely nothing of the effects of climate upon the temperature, periodicity, or degree of activity of the subterranean waters, directly or indirectly. The relations, if any, existing between the different craters are almost equally undetermined. Even the sources of the water supply and the nature of the heating and projecting agencies are but vaguely understood. In fact nothing connected with the whole subject is well ascertained and the opportunity for *original* investigation is almost unlimited.

It is also quite possible, not to say probable, that many craters which have not yet been seen in action may hereafter prove to be among the most interesting and important geysers. Dr. Hayden describes, in his report for 1872, eruptions of geysers which were not observed the previous year, while two or three which were seen in action in 1871 were not observed in 1872. At least two new ones, I have reason to believe, were seen by myself during the summer of 1873, in the Upper Fire Hole Basin alone. Nor is this all, for there is little doubt that future exploration will be rewarded by the discovery of still other basins or collections of thermal and spouting springs. Notwithstanding the extensive surveys in our western wilds, there are many complicated problems to solve and numerous discoveries to make ere we shall fully realize the vastness and extent of nature's variety.

All observations should be connected.—Any system of observa-

*Northwestern Wyoming expedition.

†I am aware of no case in which any person capable of careful observation has spent so much as one week in recording a series of facts from one locality.

tion, however comprehensive, will be comparatively futile, unless the work of all engaged shall be so connected as to prevent confusion and secure the strength of united effort. This proposition is obvious enough to need no demonstration. I will, therefore, pass directly to the subject next at hand.

It will be seen, by reference to the bill previously quoted, that it is made the duty of the Secretary of the Interior to "provide against the wanton destruction of the *fish* and *game*, etc.," within the reservation. I have already given a list of the principal mammals and birds of this region,* from which those properly included under this head of *game* will readily be selected. Accepting this term in its widest sense, we may, perhaps, infer that this provision, if rigidly-executed, will insure the protection of the greater number of the animals mentioned in this list. This, in a measure, secures the fulfilment of the scheme which I have proposed for the *preservation* of these animals. A moment's thought, however, will show the inadequacy of such means, for, in the first place not all of the forms included in my list are representatives of the park fauna, nor is it certain that mere *protection* would, in all cases, be equivalent to *preservation*.† Besides as I have stated, not a few of the species alluded to are well on the way to extinction, and great care might at times be required to prevent extermination. I have not space to consider these points as I could wish, but a few of the facts will not be out of place.

Among the *foreign* animals which I have suggested for introduction into the National "Zoological Gardens" is the bison, which, being erratic in its habits, would need some attention until egress from the park should become disadvantageous to it by the settlement of the surrounding country.‡

The American moose (*Alce Americanus* Jardine), the mule deer (*Cervus macrotis* Say), the big horn mountain sheep (*Ovis montana* Cuvier), and the mountain antelope (*Aplocerus montanus*), wrongly named the Rocky Mountain goat, are undoubtedly among

* See First Part, of this article.

† Besides the animals referred to, it seems to me quite possible to domicile in this region, a few at least of those species of other faunas which are in danger of rapid extermination; at any rate, experiments of this nature could do no harm, and they might often prove very beneficial.

‡ I have called the bison a *foreign* animal, because it is not now found within the limits of the reserved tract, but that it would thrive there if introduced is already proven by the abundant remains which are now bleaching in the valleys both within and adjacent to the park, showing that they have but recently been driven from these haunts.

the most valuable and interesting of the denizens of the Rocky Mountains, and I cannot believe that we have yet reached the limit of the adaptations of the order Ruminantia to the wants of man.*

The interesting case of the suckling of the young by the males of *Lepus Bairdii*, before mentioned, ought not to be overlooked, and there are doubtless many discoveries yet to be made of equal interest. The order Rodentia is well represented in this section.

There are many other points of greater or less importance which have occurred to me in connection with the plans of improvement which I have to suggest, but I must be content with a passing allusion to them. I cannot forbear, however, calling attention to one very prominent result to be attained by the setting aside of this tract, and the consequent preservation of the timber, as provided by law. It needs no argument to show the value of the Upper Yellowstone forests as a means of equalizing the distribution of the precipitated moisture, which is collected by the various streams radiating from this point. For many years to come, the timbered district within and around the park must be the main support of the settlements in that region, for without this influence irrigation during a considerable portion of the year will be impossible. Until artificial forests, so to speak, have been produced along the lower valleys of the streams, upon the plains, these timbered areas must constitute the very backbone of successful agriculture. Such being the case, there are few who will not welcome the introduction of most stringent measures for the protection of the wooded districts. Nor is this all, for there are, doubtless, not a few questions of much importance upon which new light will be thrown by the discoveries resulting from the preservation of new and rare forms of plants in these forests.†

*In the Report of the Dept. of Agriculture, 1867, p. 218, an anonymous writer gives a short article with a good plate of *Aplocerus montanus*, from which I extract the following:—"Mr. Lord deems the Aplocerus a valuable animal to acclimatize, and thinks it would thrive among the mountains of Scotland, and prove a remunerating 'wool-bearing animal.' Its coat is very thick, and is composed of two classes of hair, one extremely long and somewhat coarse, beneath which is a short, dense covering, very fine, 'as delicate in fibre and texture as that of the famous goat of Cashmere. The outer coat of hair is very long, covering the body, tail, and legs, like the fleece of the merino, being most abundant on the shoulder, neck, back, and thighs.'" . . . "It would be worth while to ascertain more definitely the precise habits and capabilities of this American animal, and ascertain its pecuniary value, before searching farther through Asia for goats to acclimatize upon this continent, etc."

† That thousands of acres of valuable timber have been (not uncommonly) destroyed by the neglect to extinguish a camp-fire, is a fact which is patent to all who have trav-

The question now naturally arises, What can be done to carry out the several schemes proposed in this paper? This I shall endeavor to answer as fully and briefly as possible. There is one difficulty in dealing with all questions bearing upon the subject of government aid to science, which is that there exists no settled plan of action upon such matters. Those who are most deeply interested have neither time nor inclination to "lobby" for the passage of a bill, much less have they the means with which to purchase its passage by bribery, or the effrontery to offer it. Science is thus left dependent, in too many instances, upon the purely accidental good results which may follow or not, as the case may be. If the idea of a free national park for the benefit of the people is at all consistent with our republican institutions, nothing can be more plain than the duty of government to provide for its maintenance. But the Yellowstone Park, as we have seen, has manifestly a peculiar value aside from its utility as a mere "pleasuring ground," and thus it offers, without material outlay, unusual returns upon the investment.

For purposes of study, it would be best to divide the park into four nearly equal districts, with a small central district. The latter would comprise very few of the objects of great interest, but would contain the central station, which might best be located at the outlet of Yellowstone Lake. The four main districts would thus vary much in point of interest, but the work of research could readily be equalized by proper care and foresight. A chief commissioner, a person of acknowledged ability, occupying the central station, would then be placed in charge of the whole area, with competent officers under him and responsible to him for the performance of their duties. Each of the large districts should contain a principal station centrally located, and as many local stations as might be required for observation and experiment. In other words, we should have what may be styled a perpetual expedition with head-quarters at the central station, composed of several divisions, working in separate fields, each provided with a competent scientific corps of investigators with their assistants.

I have given here the mere outline of a scheme which appears

elled through an uninhabited country. In the face of repeated warnings, there are many who will never learn to adopt the simple precaution of smothering their fires before abandoning them. It has been recommended, and not unwisely, that such wilful neglect should be made a criminal offence.

to me the most practicable and advantageous, simply because I have not the opportunity in this article to enlarge upon its scope and its adaptability to the end in view, but I believe that such a plan will be found adequate for the maintenance and utilization of the park in such a manner as to produce the most satisfactory scientific results; while, as I have shown, there is need of prompt action in some directions, it is not necessary, however desirable, that the whole of this plan should be inaugurated at once. On the contrary, time and money may be saved by beginning upon a small scale, and gradually widening the scope of observation. Eventually, however, such a scheme must lead to the introduction of observers in every important department of scientific research.

The most unpleasant part of the whole subject is the pecuniary difficulty, but I would gladly repose sufficient confidence in the culture of my countrymen, to believe that an enumeration of the immediate practical results to follow from this investment is unnecessary to convince them of its desirability. For the present, no method of accomplishing this plan seems available, except a grant from the General Government of an amount sufficient for the labors of a single year, but we may be justified in hoping that the judicious application of the first grant would render future appropriations more apparently necessary. It would not be difficult to demonstrate the propriety of a large endowment for the improvement of the park, but it is foreign to the objects of this paper, which have been to show the value of the tract, and, in a general manner, to show how it may be used to advantage, without discussing minutely the means to be employed for this purpose.

If the suggestions here made shall aid, in any degree, in advancing the cause of scientific research, more will have been accomplished than the writer has dared to hope.